The Effects of Lactide and Caprolactone on Hot-Melt Pressure Sensitive Adhesives

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My project was based on studying the effects of lactide and caprolactone on hot-melt pressure sensitive adhesives, with the goal of identifying which ratio of the two reagents produced the best adhesive polymer, by May 8, 2015. My project was supported by the Undergraduate Research Opportunities Program (UROP) through the University of Minnesota – Twin Cities, and I performed my research under the supervision of Professor Steve Severtson Ph.D., in his labs. After a couple weeks of training led by Cheng Gu, one of Professor Severtson's graduate students, I started my research by planning out the reagents, procedures, and time necessary to study the effects of lactide and caprolactone. I decided to create thirteen batches of adhesive polymer, with one batch acting as a control and the other twelve composed of different ratios of lactide to caprolactone. The synthesis of these adhesive polymer batches used toluene, lactide, caprolactone, 2-hydroxyethyl methacrylate, tin(II)-2-ethyl hexanoate, ditert-butyl peroxide, acetone, acrylamide, methylstyrene, and 2, 2'-azobis(2-methylpropionitrile). The plan for the project was to create these thirteen batches, characterize them using nuclear magnetic resonance (NMR), and to test each batch's adhesion and cohesion properties, in order to determine which ratio of lactide to caprolactone yielded the best adhesive polymer product.

After distilling and vacuuming away the solvents from the first batch of adhesive polymer product, I quickly learned that it was too viscous to be removed from the round bottomed flask containing it. This meant that even though the desired product had been synthesized, it could not

be removed from the flask for characterization or property testing. To fix this problem a new synthesis recipe was created by substituting acrylamide and methylstyrene with 2-hydroxyethyl methacrylate and methyl methacrylate with the goal of creating a less viscous adhesive polymer. After creating a few of the thirteen batches of adhesive polymer with the new recipe, and being able to remove them from the original round bottomed flask, I could tell that this new recipe was a success. However, a new problem arose when one of my two nitrogen tanks ran out of gas. This along with other small problems throughout the semester slowed down my progress. By the first week in May, I was able to finish creating the thirteen batches, vacuum out their solvents, and transfer them into individual glass jars for later characterization and property testing, but did not have enough time left before my deadline to perform these tests. Figure 1 shows a picture of twelve of the thirteen batches that I successfully created.

Figure 1: This picture shows batches 1-12, with batch 13 (the control batch) not pictured. Each glass jar is labeled with the adhesive polymer contained inside.

I was effective at reaching the goal of creating 13 adhesive polymer batches, but not effective at identifying which ratio of lactide to caprolactone produced the best adhesive polymer. As I was trying to reach my goal, I also discovered that the helpful change in viscosity was due to the substitution of reagents, learned the importance of conserving the nitrogen gas in the tanks, became more aware of watching the PSI units on the nitrogen tank used when purging solutions, and was taught how to vacuum solvents away from a solution. If given more time, I would characterize the thirteen finished batches with NMR and test the adhesion and cohesion properties in order to determine the best ratio of lactide to caprolactone for hot-melt pressure

sensitive adhesives. If I were to do this research again, one thing I would do differently is purge my solutions with the nitrogen gas for less time. I hypothesize that I ran out of nitrogen gas so quickly because I had purged each of my adhesive polymer batches, with the first recipe, for eight hours using the nitrogen gas. Had I only purged each batch for ten minutes, I may not have run out of gas so quickly.

Finally, I am very thankful for my UROP experience. Through this program and Professor Severtson's permission, I have been able to learn more about polymers and adhesives as well as learn how to work in a lab with minimal supervision. It taught me how to deal with small problems in the lab on my own instead of constantly bombarding my supervisor with questions. I would definitely recommend other students to take advantage of the Undergraduate Research Opportunities Program.